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Cyber/IT Test Development: Project Overview

Presentation to the DoD HFE TAG

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Briefing Outline

- **Why develop a cyber/Information technology (IT) test?**
- **Cyber/IT Test Development Project Overview**
  - **Phase 0: Literature Review COMPLETED**
  - **Phase I: Initial Development/Pilot Testing COMPLETED**
  - **Phase II: Predictive Validation Study COMPLETED**
  - **Phase III: MEPS Data Collection COMPLETED**
  - **Phase IV: Pre-Implementation Issues IN**

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Why Develop a Cyber/IT Test?

- Over the last decade computer & network security and vulnerability issues have increased dramatically in importance
- 2002: National Academy of Science report emphasized importance of cyber security in the wake of 9/11
- 2006: US Air Force announced cyberspace will constitute a new mission domain
- 2006: Expert Review Panel examined ASVAB content specifications & administration issues:
  - Recommended development of an information/ communications technology literacy knowledge test to supplement current ASVAB content
- Competition for high quality cyber/IT personnel is great (industry, government, & military)

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Phase 1: Cyber Test Taxonomy

Broad Area IT	Cluster	Example Knowledge Statement
Networking & Communications	Network Configuration Maintenance	Knowledge of Network protocols & standards
	Telecommunications	Knowledge of telecommunications topologies
Computer Operations	PC Configuration& Maintenance	Knowledge of file structure
	Using IT Tools/Software	Knowledge of uses & general features of a word processing software
Security & Compliance	System Security	Knowledge of security methodologies for routing devices
	Offensive Methods	Knowledge of encryption & decryption methods
Software Programming & Web Design	Software Programming	Knowledge of basic language constructs
	Database Development & Admin.	Knowledge of database querying methods
	Web Development	Knowledge of web-based data environments
	Data Formats	Understanding differences between data formats
	Numbering Systems	Understanding of different numbering systems, such as hex & binary

Phase II: Incremental Validity

Observed & Corrected for Range Restriction

Occupation/Course	n	AFQT corrected r	AFQT + EI corrected R	AFQT + EI corrected ΔR	AFQT + Cyber/IT corrected R	AFQT + Cyber/IT corrected ΔR	AFQT + Cyber/IT observed R	AFQT + Cyber/IT observed ΔR	Cyber/IT observed & corrected r	Cyber/IT observed & corrected r
AF - 1N4X1 Network Intel	79	.609	.621	.012	.611	.002	.247	.002	.15ns	.46
AF - 2E1X1 Satellite Sys	138	.720	.737	.018	.741	.021	.425	.051	.34	.66
AF - 2E1X3 Grnd Radio	170	.819	.826	.008	.836	.018	.570	.035	.43	.77
AF - 2E2X1 Network Sys	160	.730	.788	.060	.772	.043	.461	.127	.43	.74
AF - 3C0X1 C- Op	188	.732	.736	.004	.768	.035	.525	.085	.46	.69
AF - 3C2X1 C-Ctr	147	.646	.650	.004	.665	.019	.501	.033	.35	.48
NAVY – IT	183	.759	.761	.002	.766	.007	.404	.029	.31	.61
NAVY – CTN	61	.687	.716	.029	.697	.010	.391	.043	.34	.53
							.44			

Phase III: MEPS Testing

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- Over 50,000 military applicants were tested (Army, Navy, & Air Force)
- 4 experimental test forms used
- Developed norms/subgroup norms
- Examined relations with ASVAB tests
- 2 “operational” forms were produced

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Phase III: MEPS Testing

Expected Scores Correlations with ASVAB Tests

ASVAB	Cyber/IT
AFQT	0.66
AO	0.36
AR	0.54
AS	0.38
EI	0.61
GS	0.61
MC	0.56
MK	0.45
PC	0.58
VE	0.62
WK	0.62

Cyber/IT correlations with ASVAB scores provide insight why incremental validity is small despite special knowledge content

Phase III: MEPS Testing

Expected Scores Subgroup Differences

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Test	$d_{(male-female)}$	$d_{(white-black)}$[1]	$d_{(white-Hispanic)}$[2]
Cyber/IT	0.44	0.55	0.36
AFQT	0.30	0.81	0.48
AO	0.19	0.59	0.14
AS	1.05	1.14	0.62
GS	0.56	0.99	0.61
EI	0.83	1.00	0.60
MC	0.82	1.09	0.55

1. **Non-Hispanic White vs. non-Hispanic Black**
2. **Non-Hispanic White vs. Hispanic White**

Content of Operational Forms

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Content Area	Form A		Form B	
	N Items	Percent	N Items	Percent
Networking & Communications *Network Config. & Maint.*	7 *4* *3*	24 % Target = 27%	7 *4* *3*	24% Target = 27%
Computer Operations *PC Config. & Maint. Using IT Tools and Software*	12 *6* *6*	41% Target = 36%	12 *5* *7*	41% Target = 36%
Security & Compliance *System Security Offensive Methods*	7 *4* *3*	24% Target = 23%	7 *3* *4*	24% Target = 23%
Software Programming & Web Design	3	10% Target = 14%	3	10% Target = 14%
TOTAL	**29**	**100%**	**29**	**100%**

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Phase IV: Pre-Implementation Issues

- Integration of Cyber Test Scores into Classification Process
- Scoring and Reporting Process/Responsibility
- New Item and Form Development
- Additional Validation Studies
- Other Issues

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Phase IV: Pre-Implementation

Integration Into Classification Process

- **Use Cyber Test to expand applicant pool**
  - **e.g., if current minimum qualifying score for cyber/IT specialties were General = 55, allow applicants with slightly lower General scores (50 ≤ G < 55) and high Cyber Test scores (≥ 60) to qualify**
- **Create new ASVAB classification composite that includes Cyber Test**
- **Create new classification composite that combines ASVAB, Cyber Test, and personality (TAPAS)**

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Phase IV: Pre-Implementation

Scoring & Reporting Responsibility

- **Projected to be completed as of 2 June 2014:**
  - **MEPCOM assumes full scoring and reporting functionality**
  - **Make fully operational for all Services at MEPS**
- **Need to do:**
  - **Cyber Test score produced and stored electronically in an all-service accessible database**
  - **Scores can be accessed by the Services for immediate classification decisions**

Phase IV: Pre-Implementation

New Item & Form Development

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- **Develop 190 new cyber/intel-related items (done)**
- **Administer the items at the MEPS (done)**
  - ***Seeding experimental items into existing forms***
- **Develop new forms (nearly done)**
- **Create norms, evaluate potential adverse impact, and conduct factor analyses (in progress)**
- **Concurrently seed experimental items into current forms of the Cyber Test, an ongoing process for future test development**

Phase IV: Pre-Implementation
Additional Validation Studies

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- **Ongoing criterion-related validation (of *current* Cyber Test)**
  - **R_{xy} Cyber Test with Final School Grade for new cyber Air Force Specialties (AFSs) (in progress)**
  - **R_{xy} Cyber Test with Final School Grade for current cyber AFSs (initial analysis done, results below)**

Air Force Cyber Composites Development Observed Correlations (N = 686)

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AF Cyber (3Ds, 1N2s, 1N4s) 'B' AFS-awarding course Final School Grade (FSG).

FSG = ASVAB + CyberTest + TAPAS

FSG = General 'G' composite + Cyber + (- Sociable - Tolerance + Achievement)

Step	Block	R	R^2	ΔR^2	Contrast	Contrast Description
	Cyber	.368	.135			Cyber alone
	TAPAS	.236	.055			TAPAS alone
1	G	.348	.121			G alone
2	G+Cyber	.412	.170	.049	2-1	Cyber over G
3	G+TAPAS	.397	.158	.037	3-1	TAPAS over G
4	G+Cyber+TAPAS	.443	.196	.038	4-3	Cyber over G+TAPAS
				.026	4-2	TAPAS over G+Cyber
				.075	4-1	Cyber+TAPAS over G

AF Cyber Composites Development Range Restriction Corrected Data (N = 686)

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Step	Block	R	R^2	ΔR^2	Contrast	Contrast Description
	Cyber	.563	.316			Cyber alone
	TAPAS	.318	.101			TAPAS alone
1	G	.595	.354			G alone
2	G+Cyber	.624	.389	.035	2-1	Cyber over G
3	G+TAPAS	.617	.381	.027	3-1	TAPAS over G
4	G+Cyber+TAPAS	.638	.407	.026	4-3	Cyber over G+TAPAS
				.018	4-2	TAPAS over G+Cyber
				.053	4-1	Cyber+TAPAS over G

Note. Data corrected for range restriction (Law ley, 1943); N = 686

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Phase IV
Other Issues

- Strategy for using new forms
  - Review current test forms/items for obsolescence/item drift
  - Develop 5-6 new forms that use items from existing forms and new items
- All service test: Add CyberTest to ASVAB – (AF, Army, Navy, USMC)
- Data-basing scores from MEPS
  - Possible solutions? Navy CS, AF TAPAS processes?
- Make CyberTest Adaptive?
  - Preliminary discussions with DMDC indicate this is possible with new item pool
  - What difficulty/discriminability level?

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Summary

- There is a lot of interest across the Services in a Cyber/IT test to improve classification
- There may be differences in how each Service uses the test scores
- Cyber/IT scores show modest incremental validity when used with the ASVAB
- Cyber/IT scores show smaller subgroup differences compared to ASVAB technical knowledge tests; may reduce adverse impact
- Cyber/IT test content is more prone to technology change than other technical knowledge tests

BACK UP SLIDES

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Cyber Test Project History

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Entry-level Cyber Test (Formerly ICTL)

- ASVAB Expert Panel recommended developing a Information Technology knowledge test that the ASVAB did not cover
- Phase 0 Literature Review (FY 2007)
- Phase I Cyber Test Development and Pilot Testing (FY 2008)
- Phase II Cyber Test Validation Study (FY 2009)
- Phase III Cyber Test Applicant Administration (FY 2011)
- Phase IV Cyber Test Composite Formation and Standard Setting (FY 2012)
- **Phase V Cyber Test Implementation for operational use (and new item seeding platform for Cyber Test) (CY 2013, FY 2014)**

Next Generation Cyber Test

- **Phase I New Cyber Test: Expand Item Pool and Develop New Forms (CY 2013)**

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Phase IV: Pre-Implementation

~~Form Development~~

- **Evaluating options for IRT calibration to best maintain operational scale established in phase III**
  1. **Estimate transformation coefficients**
     - **Stocking & Lord (1983)**
     - **Current operational items as anchors**
  2. **Fixed theta calibration**
     - **Assign theta based on operational items**
     - **Derive parameter values for newly developed items**
  3. **Fixed parameter calibration**
     - **Fix operational parameter values**
     - **Estimate values for newly developed items**

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Phase IV: Pre-Implementation

Form Development

- **Form Assembly**
  1. **Evaluate obsolescence/drift in current operational item pool**
  2. **Eliminate suspect items**
  3. **Combine surviving operational items with newly developed items to form a single operational item pool**
  4. **Develop 4+ “parallel” forms using Automated Test Assembly (van der Linden, 2005) procedure**

Phase IV: Pre-Implementation

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Additional Validation/Classification Analyses

- **Objective: Evaluate classification efficiency potential of Cyber Test (CT)**
  1. **Can CT produce incremental validity over MAGE/ASVAB <u>differentially</u> across AFSs or types of AFSs (e.g., cyber vs non-cyber AFS)?**
  2. **Can CT incrementally increase mean predicted performance (MPP; e.g., average FSG) over MAGE/ASVAB, overall and across AFSs?**
  3. **Can CT incrementally expand pool of qualified applicants (i.e., lower cut scores) while retaining MPP?**
- **Analysis Data**
  - **Applicant sample with ASVAB, MAGE, and CT from large scale applicant administration in phase III**
  - **Accession sample with ASVAB, MAGE, CT, and FSG from TTMS**
- **Analysis AFSs**
  - **Select AFSs with sufficient sample size for estimating stable composites.**
  - **Select AFSs that represent various career fields, cyber AFSs, and**

AFSs that represent various career fields, cyber

Phase IV: Pre-Implementation

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Additional Validation/Classification Analyses

- **Analysis Conditions: Types of composites**
  1. **MAGE**
  2. **ASVAB**
  3. **MAGE+CT**
  4. **ASVAB+CT**
- **Analysis Approach**
  1. **Incremental validity**
     - **Calculate validities for predicting FSG from accession sample and correct for range-restriction relative to applicant sample, for each condition.**
     - **Compare validities of (MAGE+CT) and (ASVAB+CT) against MAGE and ASVAB**
     - **Evaluate differential incremental validities across AFSs and types of AFSs**

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Additional Validation/Classification Analyses

- **Analysis Approach (cont'd)**
  2. **Classification efficiency potential**
     - **Compute Horst's index of differential validity across conditions**
     - **High correlations + low inter-correlation produce high Horst's index**
     - **Compute MPP, overall and by AFS, based on optimal selection-classification using multivariate normal distributed criterion (Brogden, De Corte)**
     - **Compare overall MPP and AFS MPPs by conditions**
  3. **Size of applicant pool vs MPP**
     - **Compute MPP, overall and by AFS, based on optimal selection-classification on empirical applicant sample and cut scores (CS).**
     - **Evaluate range of alternative CS near existing/operational CS**
     - **Analyze extent CT expand eligible pool (lower CS) while retaining MPP by AFS and type of AFSs across**

Cyber Test Implementation

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- This particular classification strategy increases the size of qualified individuals in the applicant pool while maintaining the same level of school performance AND can increase diversity numbers.
- Other strategies could decrease the size of the qualified applicant pool while increasing school performance and graduation rates (and presumably field performance and retention)
  - e.g., maintain minimum cut scores on Electronic/General composites and rank order qualified applicants by Cyber scores
- Ideally, the entry-level cyber classification test will become part of ASVAB (not just a special test) and optimum composites can be developed
- Currently all AF applicants take the Cyber Test at MEPS, partly for research data on experimental items seeded within current test, so the move from "special test" status to ASVAB sub-test is minimal for testing time